ENGLISH TRANSLATION OF PUBLISHED JAPANESE PATENT

Publication number: 2001-023775
Date of publication of application: 26.01.2001
Title of the invention: ORGANIC ELECTROLUMINESCENT ELEMENT
Application number: 11-195340
Date of filing: 09.07.1999

[Claims for Patent]

1. An organic electroluminescent element comprising:
a first electrode formed at least on a base plate;
a luminescent layer mainly made of an organic electroluminescent compound; and
a second electrode that is disposed so as to sandwich the luminescent layer between the first and the second electrodes,
wherein the base plate is flexible and made of a polymer that transmits a visible light wave length.
2. The organic electroluminescent element according to claim 1, wherein at least one of the electrodes is comprised of a conducting polymer.
3. The organic electroluminescent element according to claim 2, wherein the conducting polymer is a transparent polymer.
4. An organic electroluminescent element comprising:
a first electrode formed at least on a base plate;
a luminescent layer mainly made of an organic electroluminescent compound; and
a second electrode that is disposed so as to sandwich the luminescent layer between the first and the second electrodes,
wherein at least one of the electrodes is comprised of a conducting polymer.
5. The organic electroluminescent element according to claim 4, wherein the base plate is flexible and made of a polymer that transmits a visible light wave length.
6. The organic electroluminescent element according to claim 5, wherein the polymer is a transparent polymer.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]
The present invention relates to an electroluminescent element comprising a luminescent layer mainly comprising an organic electroluminescent compound and a pair of electrodes that sandwich the luminescent layer.
[0002]
[Prior Art] An organic electroluminescent element (hereinafter referring to organic EL element) has a structure that has a thin film mainly comprising a fluorescent organic compound that is sandwiched by a cathode and an anode. By injecting an electron and an electron hole into the thin film, an exciton is generated. The element becomes luminous when light (fluorescence, phosphorescence) is emitted at the time the exciton is deactivated.
[0003] Such organic EL element actually has a transparent anode electrode formed on a glass base plate, a set of layers comprising an electron-hole injection layer, an electron-hole transportation layer, a luminescent layer and an electron transportation layer, each layer being formed in this order on a specified portion of the transparent anode electrode, and a cathode electrode formed on the electron transportation electrode. A specified electric field is applied between the transparent anode electrode and the cathode electrode. In addition, the organic EL electrode has a protection layer covering the electron-hole injection layer, electron-hole transportation layer, luminescent layer, electron transportation layer. In the organic EL element, an electric field is applied between the transparent anode electrode and the cathode electrode, the luminescent layer emits a specified light.
[0004] Such conventional organic EL element has characteristics that give a surface luminescent having a high brightness of about 100 to 10,000 cd/m^2 with such a low voltage of about 10V. The element also enables to realize light generation within a range from blue to red by selecting luminescent material.
[0005]
[Problems to be Solved] The conventional organic EL element is not flexible because luminescent layer or the like is formed on a glass base plate and limited to a display device having a plane surface when it is used. In other words, the above mentioned organic EL element has been used for a

plane-like display device by being disposed on a glass base plate in a matrix-like manner. As mentioned above, when the organic EL element is used for a displaying device, the shape of the displaying device is restricted to plane-like device.

[0006] The objects of the present invention is to provide an organic EL element that is flexible and is not limited to a display device having a plain-like surface.

[0007]

[Means for Solving the Problems] The above mentioned objects can be achieved by an organic electroluminescent element that comprises:

a first electrode formed at least on a base plate;

a luminescent layer mainly made of an organic electroluminescent compound; and

a second electrode that is disposed so as to sandwich the luminescent layer between the first and the second electrodes,

wherein the base plate is flexible and made of a polymer that transmits a visible light wave length.

[0008] Since the organic electroluminescent element of the present invention has a base plate having flexible characteristics, so that the element becomes flexible as a whole. In addition, the base plate is specified to be able to be transparent to visible light wave length. Therefore, luminescence of the luminescent layer can be visible from the base plate side.

[0009] Further, the organic electroluminessence element has preferably at least one electrode made of a conducting polymer.

[0010] Therefore, the electrode itself becomes flexible, so that the organic electroluminescent element becomes further flexible. In addition, the conducting polymer is not deteriorated by rust, so that the electrode can be made thinner.

[0011] Whereas the above mentioned objects can be achieved by an organic electroluminescent element that comprises:

a first electrode formed at least on a base plate;

a luminescent layer mainly made of an organic electroluminecent compound; and

a second electrode that is disposed so as to sandwich the luminescent

layer between the first and the second electrodes,

wherein at least one of the electrodes is comprised of a conductive polymer.

[0012] The above structured organic electroluminescent element of the present invention has a flexible electrode by using a conductive polymer for at least one of the electrodes. With this structure, the organic electroluminescent element can be flexible as a whole.

[0013] Furthermore, the base plate of the present organic electroluminescent element is preferably made up of a polymer having transparency to visible light wave length and having flexibility.

[0014] In this case, the base plate itself has flexibility, so that the organic electroluminescent element can further have excellent flexibility.

[0015] In the present organic electroluminescent element, the polymer is preferably to be a transparent polymer material.

[0016] In this case, light from the luminescent layer can be lead easily.

[0017]

[Embodiment of Operating the Invention] Preferable detailed embodiment of the organic electroluminescent element of the present invention will be explained hereinafter referring to drawings.

[0018] Fig. 1 is a first embodiment of an organic electroluminescent element (hereinafter referred to organic EL element) of the present invention. In Fig. 1, the organic EL element has a flexible transparent base plate 1, an anode electrode 2 formed in a stripped pattern and in a specified direction on the transparent base plate 1, an electron-hole injection layer 3 formed on a specified region of the anode electrode 2, an electron transportation layer 4 formed on the electron-hole injection layer 3, a luminescent layer 5 formed on the electron transportation layer 4, an electron transportation layer 6 formed on the luminescent layer 5, and a cathode electrode 7 formed in a stripped pattern and in a perpendicular direction to the anode electrode 2 on the electron transportation layer 6. In other words, the organic EL element has a structure that the anode electrode 2, the electron-hole injection layer 3, the electron-hole transportation layer 4, the luminescent layer 5, the electron transportation layer 6 and the cathode electrode 7 are formed in this order on the transparent base plate 1. In addition, the organic EL element is formed in

a region that is enclosed or surrounded by a partition wall 8 formed on the anode electrode 2.

[0019] The transparent base plate 1 is made of a polymer material that transmits visible light wave length. By using such polymer material, the transparent base plate 1 can have flexibility. Organic polymeric resin such as polycarbonate, polyethylene, polypropylene, polyolefine etc. can be used as such polymer material. A film having a specified thickness is formed using such organic polymeric resin and the thus obtained film can be used as the transparent base plate 1.

[0020] In addition, in such organic EL element, an oxide transparent electrode material can be, for example, used as the anode electrode 2. Indium oxide type or zinc oxide type materials can be exemplified as the oxide transparent electrode materials. Whereas, as the anode electrode 2, metals having a large work function such as Au, Ni etc. can be used from the viewpoint of injectionability of the electron-hole.

[0021] Furthermore, the electron-hole injection layer 3 is provided for improving injectionability of the electron-hole from the anode electrode 2, and is formed by using a material having a small ionization energy. Examples of these materials can be amine base materials or phthalocyanine base materials can be exemplified as the electron-hole injection layer 3.

[0022] Further, the electron-hole transportation layer 4 and the electron transportation layer 6 are provided for improving injectionability of electron-hole into the luminescent layer 5 and for improving transportationability of electron toward the luminescent layer 5. As the electron-hole transportation layer 4, such material can be used, that has somewhat low ionization energy and can contain (energy barrier) electron in the luminescent layer 5 for improving injectionability of electron hole into the luminescent layer 5. Actually, an amine base material can be used as the electron- hole transportation layer 4.

[0023] In addition, conventionally used materials can be used as the luminescent layer 5. For example, distyril allylene (DSA) base materials, oxadiazole base materials, pyrazolo quinoline base materials, benzoxazole base materials, benzothiazole base materials, benzoimidazole base materials, metal chelate compounds etc can be exemplified as such materials. Furthermore, emitting color can be changed within a range from blue to red

by choosing a kind of these materials.

[0024] In addition, in the organic EL element, the cathode electrode 7 is a layer to be used to apply an electric field to the luminescent layer 5 together with the anode electrode 2 and is formed by using a conducting polymer. As the conducting polymer, organic polymer such as polyacetylene, polyparaphenylene, polyphenylene vinylene, polyphenylenevinylene, polypyrrole, polythiopheny polyanyline, polyisothianaphthene etc. can be used.

[0025] In the organic EL element structured as mentioned above, applying a voltage of about 10V between the anode electrode 2 and the cathode electrode 7 causes recombination of an electron-hole injected from the anode electrode 2 and an electron injected from the cathode electrode 7 at the luminescent layer 5 made of an organic fluorescent material, generating excinton. The excinton emits light during deactivation process of the excinton , and the light is emitted out through the transparent base plate 1.

[0026] It is notable that in the organic EL element, the transparent base plate 1 shows flexibility, so that the element becomes flexible as a whole. In other words, when a display device is composed of the organic EL element, the display device eventually becomes flexible so that the display can be changed its shape into a desired shape, for example, a cylindrical shape.

[0027] In addition, in the organic EL element, the transparent base plate 1 can transmit visible light wave length. Therefore, the transparent base plate 1 can transmit light when the luminescent layer 5 emits light as mentioned above. Accordingly, when a display device is composed of the organic EL element, a desired image can be displayed.

[0028] In addition, in the organic EL element, the cathode electrode 7 is made up of a conductive polymer. Therefore, the organic EL element of the present invention mentioned above shows an excellent flexibility when compared with the conventional element having a cathode electrode 7 made of Aluminum or silver, or an alloyed metal of these kinds of metals and alkaline metals such as magnesium, lithium etc. Especially, when the cathode electrode 7 is made of metal, the material tends to be deteriorated by generation of rust so that it is necessary to form the electrode thicker than a specified thickness. On the contrary, in a case that the cathode electrode 7 is comprised of a conductive polymer, the thickness of the

cathode electrode can be as much thinner as possible. Accordingly, the organic EL element of the present invention can be formed to be more flexible and thinner.

[0029] Fig. 2 shows a second embodiment of the organic EL element of the present invention. In Fig. 2, same reference numbers are attached to the same parts in Fig. 1 of the first embodiment and detailed explanations of the same parts are omitted. In the second embodiment, polyisothianaphthene which is transparent is selected as the cathode electrode 12 from the organic polymers mentioned in the above embodiment 1.

[0030] The above structured organic EL element has similar effects mentioned in the above first embodiment 1. Light emitted from the luminescent layer 5 can preferably be led from on the side of the base plate 1, because the anode electrode 12 is made up of polymer material having transparency. In addition, the anode electrode 12 is made up of a polymer material. Accordingly, efficiency of electron-hole injection is improved, so that the electron-hole injection layer 3 and the electron hole transportation layer 4 can be omitted.

[0031] Fig. 3 shows a third embodiment of the organic EL element of the present invention. In Fig. 3, same parts as mentioned in Fig. 1 and 2 of the first and the second embodiments are given the same reference number, and detailed explanation of the same parts are also omitted. In the third embodiment, polyisothianaphthene that shows transparency is selected as the cathode electrode 17 from the polymer materials exemplified in the above first embodiment.

[0032] The above structured organic EL element has similar effects mentioned in the first and the second embodiments. Light emitted from the luminescent layer 5 can preferably be led from on the side of the base plate 1 as well as on the side of the cathode electrode 17, because the anode electrode 12 and the cathode electrode 17 are made up of polymer materials that show transparency. In addition, the anode electrode 12 and the cathode electrode 17 are made up of a polymer material that shows transparency, therefore, efficiency of the electron-hole injection and electron transportation is improved, accordingly the electron-hole injection layer 3 and the electron-hole transportation layer 6 can be omitted.

[0033] Fig. 4 shows a fourth embodiment of the organic EL element of the present invention. In Fig. 4, same reference numbers are attached to the same parts in Fig. 1, 2 and 3 and detailed explanations of the same parts are also omitted. In the fourth embodiment, the cathode electrode 17 is formed on the side of the base plate 1 and the anode electrode 12 is positioned far from the base plate 1.

[0034] The above structured organic EL element has similar effects mentioned in the above third embodiment, although there is a difference that light emitted from the luminescent layer 5 can be led from the cathode electrode and the base plate.

[0035] The conducting polymer layer can be formed by a chemical compound synthesizing method such as an electrolytic polymerization, a gas phase polymerization etc. or lamination of the conducting polymer layer directly on the surface of the luminescent layer or on the base plate, or pasting of a film, that is provided using an electrolytic polymerization method, on the base plate or on the surface of the luminescent layer.

[0036] Various electron acceptors or electron donors may be doped for the purpose of controlling electroconductivity of the conducting polymer material.

[0037]

[Effects of the Invention] As above mentioned, in the organic EL element of the present invention, the base plate is flexible because the base plate is made up of a polymer material having transparency to visible light wave length. Accordingly, the organic EL element of the present invention has an excellent flexibility as a whole.

[0038] In addition, the electrode shows flexibility because the electrode of the organic EL element of the present invention is made up of a conducting polymer material. Accordingly, the organic EL element of the present invention shows flexibility as a whole, prevents the electrode from causing rust, and can be thinner.

[0039] Further, the electrode of the organic EL element of the present invention is made up of a conducting polymer material showing transparency, so that emitted light is easily led from the luminescent layer.

[0040]

[Brief Explanation of Drawings]

[Fig. 1] is a cross sectional view showing an essential part of an organic EL element of a first embodiment of the present invention.

[Fig. 2] is a cross sectional view showing an essential part of an organic EL element of a second embodiment of the present invention.

[Fig. 3] is a cross sectional view showing an essential part of an organic EL element of a third embodiment of the present invention.

[Fig. 4] is a cross sectional view showing an essential part of an organic EL element of a forth embodiment of the present invention.

[Explanation of Reference Number]

1	transparent base plate
2, 12	anode electrode
3	electron-hole injection layer
4	electron-hole transportation layer
5	luminescent layer
6	electron transportation layer
7,17	cathode electrode
8	partition wall